4. INFORMATION TRANSFER BETWEEN AIR TRAFFIC CONTROL AND AIRCRAFT: COMMUNICATION PROBLEMS IN FLIGHT OPERATIONS

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INTRODUCTION

This study of problems in communications between flightcrew and air traffic controllers was prepared as a part of an analysis of information transfer problems in the national aviation system. It is adapted from reference 1, an earlier study (by the senior author) of possible effects of the Discrete Address Beacon System (DABS) Data Link on the information transfer problems reported to the NASA Aviation Safety Reporting System (ASRS); the work reported in reference 1 was performed at the request of Systems Research and Development Service, FAA.

The purpose of this report is to discuss problems in oral communication between pilots and controllers. The investigation consisted of review and analysis of pertinent information in the ASRS data base.

APPROACH

A search was conducted of 6,527 reports submitted to ASRS between May 1, 1978 and August 31, 1979. The search technique identified and retrieved reports concerning:

1. Problems in voice communications between flightcrew and ATC

2. Problems in conveying information in ATIS broadcasts (as specified in the AIM and FAA ATC Handbook 7110.65A)

3. Problems with information concerning wind shear and minimum safe altitude

In this group of reports, 5,402 information transfer problems fitting one of these criteria were identified (some reports contained more than one information transfer citation).

The research team studied selected report narratives to establish the generic types of communications problems present. A categorization of these types was developed along lines already in use in classifying ASRS reports. Ten such categories emerged:

1. Misinterpretable – phonetic similarity

2. Inaccurate – transposition

3. Other inaccuracies in content

4. Incomplete content

5. Ambiguous phraseology

6. Untimely transmission

7. Garbled phraseology

8. Absent – not sent

9. Absent – equipment failure

10. Recipient not monitoring

The retrieved reports were grouped according to these categories. The groupings were then further subdivided according to the operational regimes in which the reported incidents occurred (i.e., terminal operations, en route operations, and various special operations). Selections of these reports were reviewed to determine unique characteristics and common features.

RESULTS AND DISCUSSION

The initial pass over the data base, the first step of the search, produced a finding considered significant to the central issue of this study: 70% of the reports to ASRS involve some type of oral communication problem related to the operation of an aircraft. The nature of the problems reported varied widely, ranging from failure to originate an appropriate message to failure of the intended receiver to comprehend and confirm the message accurately.

These communications problems were subdivided into the 10 generic types listed previously. Before taking up these assessments, however, two aspects of communication difficulties require consideration: the expectation factor and the problem of conveying traffic avoidance information effectively.

The Expectation Factor

ASRS reports indicate that many instances of misunderstanding can be attributed to the expectation factor; that is, the recipient (or listener) perceives that he heard what he expected to hear in the message transmitted. Pilots and controllers alike tend to hear what they expect to hear. Deviations from routine are not noted and the read-back is heard as the transmitted message, whether correct or incorrect.

> Aircraft A was in a block altitude of 12,000–14,000 ft. The instructor pilot and the student both thought the controller told them to turn left to a heading of 010° and descend to and maintain 10,000 ft. At 10,700 ft the controller requested aircraft A's altitude. The crew responded 10,700 ft. The controller stated the aircraft had been cleared to 12,000 ft, not 10,000 ft. There are two contributing causes for this

> occurrence: 99% of all clearances from that area are to descend to and maintain 10,000 ft, and as the instructor I was conditioned to descend to 10,000 by many previous flights. The controller may have said 12,000 ft but I was programmed for 10,000 ft.

Conveying Traffic Avoidance Information Effectively

ASRS reports suggest that the least satisfactory aspect of air/ground information transfer is the conveyance of traffic advisories and avoidance information. Faults of all kinds are cited, but the pervasive difficulty that appears to underlie many of these faults is the seeming inconsistency with which information about traffic is made available.

> While descending through 12,200 MSL first officer observed and called traffic at twelve o'clock level as we were turning through 300°. Turn was continued to approximately 320° and other aircraft diverged to the left on a southeast heading with clearance of approximately 1,000 ft laterally. On inquiry, ATC indicated that the only altitude readout on a target in that area was 6,700 MSL. If our aircraft had not been turning in on heading approaching VOR, a projected collision course would have resulted. Situation discussed with ATC supervisor who indicated that a "skin paint" was later picked up on other aircraft but later lost by adjacent center. Other aircraft apparently operating without transponder would be primarily cause of this incident. Contributing would be difficulty in picking up front profile visually at such closing speeds. Other aircraft made no evasive action and we assume he did not observe us.

In the present system, air traffic controllers provide traffic advisories as an "additional service," which means that workload permitting, the controller will issue advisories on traffic that he observes when he is not occupied with higher priority duties. This results in pilots failing to receive traffic advisories on aircraft that are not readily seen on radar – especially those that are not transponder-equipped. In addition, it is during periods of high traffic that the workload of the controller is likely to preclude issuing traffic advisories – precisely when the need is the greatest.

Generic Types of Problems in Oral Communications

Thousands of ASRS reports cite the difficulties in the exchange of information through the use of oral communications. Some reports concern transfer of information between ground facilities or personnel within such facilities. The greater number of reports concern air/ground communications and a very small number concern air communications alone.

Air/ground communications are conducted by voice radio as they have been for about 50 years. During that time technical advances have improved the quality of voice transmissions and mitigated atmospheric or induced electronic interference. Remaining technical problems include blocked transmissions, line-of-sight limitations, and hardware failures that remain undiscovered until the next occasion for a communication arises. However, the retrieved ASRS reports concerning problems in air/ground communications indicate convincingly that most of such communications problems involve human error.

Misinterpretable – phonetic similarity– The "phonetic similarity" category was assigned when similar-sounding names or numerics appeared to lead to confusion either in meaning or in identity of the intended recipient, thus causing an information transfer failure. A total of 71 reports were classified in this category. The following narrative is typical.

> We were cleared into position on runway 32L for an intersection takeoff. After a brief hold in position we received what I thought to be a takeoff clearance. I then repeated "Roger, ACR 122 cleared for takeoff, straight out departure." There was no response from the tower until we were well down the runway approaching V-1 speed. The tower controller then said rapidly, "ACR 122 that clearance was not for you, it was for ACR 142." We heard no other trip respond to the takeoff clearance but possibly we responded at the same time as ACR 142 so that tower was unaware that we had both answered and blocked each other's response.

Most reported phonetic similarity problems involved execution of clearances by someone other than the intended receiver.

Inaccurate – transposition– In the group of ASRS reports reviewed, there were 85 in which some part of the message was misunderstood because of a transmitted or recipient-perceived error in the sequence of numerals within the message. This type of error seems to occur most often when ATC gives assigned headings or distances in conjunction with changes in assigned altitudes in the same clearance. Heading 270 might be heard as a new assigned altitude. The readback then might not be perceived as incorrect (expectation factor) and an incident might result. One ASRS report illustrates this problem.

> F/O flying, Captain working radio, Center gave clearance to descend, (either) (1) to cross 10 DME east at 240 or (2) to cross 24 DME east at 10, F/O set 10,000 ft altitude and 24 DME, and started descent. Leaving 19,200 Center advised we should be at 240. Captain advised we show 10 at 24 DME, but what altitude did he want at this time, he then said maintain 180.

Other inaccuracies in content– Other reports cited inaccuracies for reasons other than phonetic similarity or transposition. There were 792 indicating a message problem of this category. Generally, they involved messages that were accurately transmitted and received, but they contained, or were based on, erroneous data (formulation errors), or, to a greater degree, they were the results of errors of judgment in the originator's decision process. This resulted in the relatively large number of reports in this category.

> Faster aircraft B was overtaking aircraft A so I issued headings that would provide lateral separation. Later aircraft A requested deviation around weather that I did not observe on radar. Thinking that a route direct to XYZ would maintain lateral separation and provide A with necessary deviation, I issued the clearance. The clearance brought A back south and since I only had 5 miles in the first place, I immediately lost separation.

Other reports in this category reflect conflicts in the interpretation of a message between the sender and receiver where there is no obvious explanation for the difference in understanding.

> Lift off runway 31 climbing to 5,000 per SID. On initial contact flight was cleared to 12,000. Subsequent transmission received and acknowledged to climb to 14,000 and maintain speed less than 250 knots until 13,000 or above. Traffic was observed at one o'clock on converging course descending. When our flight left 13,000 ft Departure Control asked our altitude and advised us to descend to 12,000 and increase speed. No member of the crew either heard or acknowledged such a message.

Incomplete content– A reported problem communication was classified as "incomplete" when the originator failed to provide all of the information necessary for the recipient to understand it properly. There were 296 reports classified in this category in the study group.

> Between LIT and FAM we were cleared for a Farmington transition to 30 left. To the best of both pilots' recollection, no statement was made by the controller to "expect a profile descent," when the clearance for a Farmington transition was given. A flight was in the Farmington area climbing to FL230. Upon hearing aircraft B talking with Center, we volunteered our altitude as being FL240 and we leveled off. I was watching B at FL230 and no evasive action was required.

In this example the requirement for profile descent was not effectively transferred, whether because of input error, failure to comprehend, or a failure of the voice radio system. These failure causes are characteristic of the reports in the "incomplete content" category.

Ambiguous phraseology– A reported problem communication was classified as ambiguous or misleading if the composition, phraseology, or presentation of the message were such that the recipient would tend to misinterpret or misunderstand the message when receiving it under normal conditions. There were 529 reports in which this kind of message problem was cited.

> We were being vectored downwind when the controller said to plan on a visual approach to runway 28. At this time we were at 6,000 to stay above departure traffic. We were assigned heading of 100 and cleared to 4,000. At this point we were south of runway 28 abeam the airport. Controller said, "The runway is nine o'clock and 3 miles, can you see the runway? We responded yes. He said, OK, turn to 360°. At this point we started our turn and (thinking we were cleared for a visual approach) began a descent. He asked our altitude at 3,400. Then he said he had not yet cleared us below 4,000 but to stay where we were. Shortly thereafter, he then cleared us for a visual and changed us to the tower.

Untimely transmission– Messages were classified as untimely if they originated too late or too early to be useful to the recipient. There were 710 reports that indicated this message problem.

> Departure clearance was left turn after takeoff to 120°, climb and maintain 7,000. We had just cleaned up and finished the climb checklist and at about 4,500 ft Departure Control gave us VFR traffic at twelve o'clock less than a mile. The Captain spotted the traffic and pointed it out to the F/O who was flying and nosed the aircraft over into level flight to go under aircraft B 50 to 100 ft and slightly behind him about 100-200 ft. Aircraft B saw us just before we passed under and behind him – he flinched just enough to slightly raise his left wing. We feel that

radar should have had aircraft B in radar contact at the time we took off and we should have been advised of the traffic at or before takeoff.

Garbled phraseology– Messages were coded as being garbled if information content was lost or severely distorted so that the recipient was unable to understand the intended message. There were 171 such reports in the study report group.

> Departed on runway 27 with a right turn to 300°. After takeoff the heading was amended to 330° but the transmission did not come through clear to us and it was mistaken for 030°. Subsequently we learned that our read-back to the controller was not received clearly and it was assumed that we had received 330° instead of what we interpreted to be 030°. Obviously, too much assumption, probably assisted by the unusually clear weather. We later learned that our error had brought us in conflict with aircraft B that had taken off immediately in front of us. Radar had us less than a mile from aircraft B when we passed.

Absent – not sent– Problem communications were assigned to the "absent – not sent" category when there was a failure to originate or transmit a required or appropriate message. In the study sample, 1,991 reports were classified in this subset. The large number is due to a broad interpretation that an appropriate message would have broken the chain of events that resulted in a hazardous occurrence. This could consist of either a point of information or an air traffic control clearance.

> Runway 9R in use – (heading 120 and told to expect a new heading when in the air). The aircraft ahead of me was issued right turn to 240 or 270. I was left on 120. This heading aimed me toward aircraft B and I felt very uncomfortable. When Tower did not give me an immediate turn, I contacted departure radar expecting the other turn. After radar contact was established, the departure man asked me to go back to Tower and upon returning he (Tower) told me I should have expected the second turn from him. If Tower had issued "expect further clearance from him," it would have made this clear and concise.

Absent – equipment failure– Problem communications were categorized as "absent – equipment failure" when a failure caused a complete loss of the message. The study report group contained 153 of these reports. This finding suggests that the equipment in use is reliable when compared to the human error-initiated problems in message transfer that are reported to ASRS.

> Aircraft A and aircraft B were being vectored to Detroit Metro Airport by Approach Control. Aircraft C was being vectored to Willow Run airport on the same frequency. The microphone button became stuck on C. As a result the approach controller was unable to communicate with A or B and less than standard separation occurred. The two aircraft were within approximately 500 ft vertically, the pilot of B called the tower controller and advised there was a stuck mike on Approach Control. The tower controller, using the information on his radar display, attempted to descend and turn B to avoid the conflict. However, the situation had deteriorated to the point that the conflict could not be avoided. Aircraft B apparently took evasive action.

Loss of communication is an extremely frustrating experience for an air traffic controller. He is usually helpless to take action to preclude a hazardous consequence. In the above example, one pilot had the presence of mind to contact the tower after noting the approach control frequency was blocked due to the stuck mike, but it was too late to avoid loss of separation.

Recipient not monitoring– A problem communication was placed in the "recipient not monitoring" category if the recipient failed to maintain listening watch, proper lookout, or failed to read available correct information. There were 553 reports in this classification.

> A conflict occurred between aircraft A on my frequency and aircraft B on Approach Control frequency. Aircraft A was departing and B was arriving. I was not aware that the B flight was in the area and the conflict was first noted by an approach controller who must have seen what happened. An investigation followed showing that the approach controller who had handed off A to me failed to coordinate all aspects of control to me as per letter of agreement between our facilities, and I failed to catch the mistake when A came on my frequency. Poor coordination between controllers and not properly listening to the pilot's initial contact were contributing factors in this incident.

A substantial number of reports in this category described the results of traffic advisories not being issued when the reporter alleged or inferred that the traffic could and should have been seen on radar. It may be technically correct that a specific target was not seen because of inattention to the particular area in question, and, therefore, the area was not being monitored by the radar controller. It appears, however, that many pilots expect traffic advisories at all times if they have been advised that they are in radar contact.

Another case is the failure of the flightcrew or the controller to receive a message or initial broadcast or to respond to a call when time is critical. In some reported cases the controller became aware that his original plan for providing separation was not working, and he then attempted to correct the situation at the last moment. Lack of instantaneous response gave rise to the allegation that a proper listening watch was not being maintained.

Communications Problems Related to ATIS

The data base was searched for reports that concerned (1) items of information contained in the present Automated Terminal Information System (ATIS), (2) broadcast problems with ATIS, and (3) indications of both a communication message problem and at least one item of ATIS information. In addition, reports concerning wind shear and minimum safe altitude warning were identified. (ATIS items of information included in these broadcasts are specified in the Airman's Information Manual and the FAA Air Traffic Control Handbook 7110.65A.)

An interesting finding of this search was that relatively few of the message problem reports were concerned with terminal information services; only 50 such reports were retrieved. It had been expected that there would be a large number of reports of difficulty in understanding the ATIS broadcasts. A considerable number of such reports were received in early ASRS operations (1976 and early 1977), but they decreased to a smaller number during the search period of this study. This suggests that improvements have been made in response to several FAA directives aimed at poorly prepared ATIS tapes, use of excessively rapid rates of speech, and technical problems with ATIS broadcast equipment. It may also suggest that difficulty in understanding ATIS is judged by airmen to be a minor matter, one that is easily overcome by repeating the broadcast and therefore not worthy of an ASRS report. In any case, most terminal-information-related reports described problems with ATIS that had substantially more serious consequences than having to listen to a broadcast a second or third time.

The problems present in the terminal information segment of the retrieved reports were classified as follows:

1. Unintelligible transmissions

2. Obsolete approach/runway-in-use information

3. Noncurrent runway visibility readings

4. Obsolete weather information

Unintelligible transmission— Reporters have cited difficulty in receiving ATIS broadcasts because of the rate of speech and the quality of the recording.

> On a VFR flight to ICT late in October, I had to listen to the ATIS seven times to get active runway, wind, altimeter setting because of the rate the words were spoken – too fast. As a low-time pilot my workload when landing at an unfamiliar airport is higher than it should be; I check and double check everything and it is unsettling to be unable to get the information needed. Most places I've been that use ATIS – Chicago, Milwaukee, Madison, Rockford – it seems that making the tape has become a chore so it reads as fast as possible to get it over.

* * *

> ATIS is supposed to speed up and facilitate arrivals and departures at airports large enough to warrant its installation. This is a wonderful concept. However, on the times that I have been into airports that have it (Boise and Portland) the report has been so distorted as to be all but useless. There is no need for the person recording the information to speak as fast as he can. I do not believe that I should have to listen to ATIS more than three times at the most to have all the information straight. Once should be sufficient. But I have had to listen 5 minutes or more before I was able to clearly understand what it is the man is actually saying. Without exception, I have not been able to clearly understand the content of the ATIS broadcast the first time simply because the man spoke too fast and, for the lack of a better word, mumbled as he talked.

Obsolete ATIS data-approach/runway in use— A frequent complaint from reporters is a change of approach or active runway from the information contained in the ATIS broadcast received by the reporter.

> Planned approach and landing for runway 31R JFK. Prior to turning final, runway was changed to 22L and aircraft was vectored for ILS or visual approach to runway 22L. Visibility approximately 5 mi smoke and haze. Our aircraft was advised being vectored for 22L ILS approach to advise when runway in sight. Throughout the vector until turning on final we received the 13L ILS identification (IMOH). Both 22L and 31R share a common frequency 110.9. We reported this to Approach Control and were advised the ILS was operating normally on 22L. Not until we were established on visual approach for 22L did the ILS start operating normally with current identification. At this time Tower advised that 22L was now operating normally. Not serious in VFR but could be very confusing and possibly cause missed approach in IFR.

Runway visual range— Rapidly changing runway visual range (RVR) results in both frequency congestion and cockpit distraction at the most critical time in the execution of an instrument approach. Since RVR is not transmitted unless the approach is being conducted in near-minimum weather conditions, it is a critical distraction in which voice transmissions are used in the present system. In other cases the RVR appears to have been omitted or the reading was not accurate when it could have been very valuable to the pilot on approach.

> Flight making ILS approach crossing outer marker, Tower reported heavy rain at airport. Speed and rate along with localizer and glide slope all were normal throughout approach. Sighted approach lights at 400 ft and began encountering light rain at 300 ft. Runway was in sight and just at touchdown encountered a wall of hard rain and had no forward visibility. I could see by the center line that we were going off the left side of the runway. We soon felt our left main gear was in the lights or possibly off to the left side of the runway. We continued forward velocity for about 1,000 ft when we again regained forward visibility at which time the captain was able to bring the aircraft back over the runway and bring it to a stop.

Obsolete weather information— Instances were reported when ATIS transmitted obsolete weather information. (These problems are similar to those reported above.)

> Approach was made VFR – on short final encountered rain (which we thought was light because Tower had not reported any). Rain was heavier than anticipated. Normal touchdown – wind from left which was not reported blew us from runway because of hydroplaning. Aircraft came to a stop just off side of runway 7R.

In another report the wind-shear factor in addition to the obsolescence of the ATIS information proved to be a problem.

> Several aircraft reported to Tower that there was moderate to severe turbulence on final approach. Flightcrew monitored Approach Control and Departure Control frequencies while waiting for takeoff. To my knowledge arriving aircraft were not advised of "wind shear"/turbulence/airspeed excursions. After our takeoff at XX55 I checked arrival ATIS – no mention of approach difficulties – in fact information was 50 min old. Despite reported hook cloud classically displayed on radar to the SW, I advised local operations of wind problems reported on final, suggesting they

advise pilots in range and that MIA dispatch also be advised – that evening about six tornadoes hit central Georgia and there was extensive tornado damage to Forest Park. Arriving A/C seemed to be left out of the information loop.

Terminal Operations

Examination of communication problems in terminal operations concerned aircraft operating under ATC control while moving on the surface at the airport, flying within the airport traffic area, or arriving and departing the terminal area. These problems are discussed below.

Communications at airports without towers were considered to be advisory only and no detailed study was made or considered appropriate to this report.

Surface operations– In connection with surface operations, ASRS reports evidence two main types of communications problems: clearance misinterpretations leading to active runway incursions and failures to communicate taxi routes to preclude wrong turns and consequent ground conflicts.

> ATIS was received advising departures on runway 4, arrivals to runway 31. Cleared to runway 4. We switched to Tower and advised we were ready for takeoff. Tower said, "Taxi up to but hold short," which first officer acknowledged, but I thought Tower said, landing was on runway 31. As I took the runway, I looked to my left and noticed an aircraft on about a 3-mile final. The error was caught by me, the tower, and the first officer at the same instant. Tower advised I was supposed to hold short. I immediately cleared the runway well before the traffic landed. Factors which I think contributed were Tower deviating from the ATIS information and then not specifically advising us. I have become accustomed to holding in position while an aircraft lands on another runway, and we are creatures of habit and I thought I heard something I obviously didn't.

Many runway incursion problems appear to result because a flightcrew acts on a clearance, onto the runway or for takeoff, intended for another aircraft. This occurs most often because of phonetic similarity of call signs or crew predisposition – expectancy.

The taxi problem is most often related to flightcrew unfamiliarity with airport layout, repairs, and changes; communications problems tend to be secondary.

Flight operations – airport traffic area– The airport traffic area is the scene of many reported system irregularities. Prominent among these are traffic conflicts with unknown aircraft or with aircraft that are not properly in the pattern or on proper approach/departure paths; traffic conflicts due to sequencing disorders; use of wrong runways; and deviations from intended aircraft trajectory (course, speed, altitude) during approach or departure. The role of communications problems in enabling these events is highly varied but is important in each class.

Conflicts with unknown aircraft: ASRS reports describe conflicts of this type often occurring when controllers are unaware of the traffic or are too busy to issue advisories. These situations fall under the general headings of absent or untimely communications problems.

> While on a heading of 270°, I was instructed to turn to a southerly heading. I checked the area off my left wing and saw aircraft B on a converging course to mine. His heading was about 300°. I advised Approach Control of the conflicting traffic and told them I needed a turn to the north to avoid traffic. It was later determined that aircraft B was not transponder-equipped and not seen by Approach Control radar. They had turned me south to avoid departing aircraft C.

Sequencing disorders: Examination of ASRS reports shows that sequencing disorders and their consequent traffic conflicts most frequently are caused by errors in a controller's planning or judgment of traffic spacing. However, communications problems enter the picture significantly; taking a sequencing control message by an aircraft other than the intended recipient is a frequent occurrence.

> I was on final for runway 25. On contacting the tower 8–10 miles out I was told to reduce to approach speed as they wanted to get a departure out. We were No. 2 following a heavy aircraft B on 2-mile final. After B landed aircraft C was told to taxi into position and hold. The pilot acknowledged. Aircraft B was told to turn off at the high-speed taxiway; B stated he could not make the high-speed turnoff. About 30 sec later Tower called "C hold your position, do not take off." This was stated twice, then the controller asked C if he had started his takeoff roll and C stated that he had and that he wanted permission to make a right turn at the first taxiway. At no time did I hear the tower clear C for takeoff.

Runway assignment errors: Use of the wrong runway for landing or taking off is a frequently reported airport traffic area problem. In virtually every case the fault is a communications problem. Most of the problems involve flightcrew misinterpretations of landing or takeoff clearances – sometimes in connection with a last-minute change in the runway assignment.

> Visibility restricted but VFR. Aircraft A reported 4-mile final for runway 9, aircraft B on right base for runway 12, aircraft C was in position for departure at threshold of runway 9. Aircraft D was holding midfield on taxiway E for departure on runway 9, aircraft D was instructed to turn left heading 360 and cleared for takeoff. Instead of departing runway 9, aircraft D started takeoff roll westbound on runway 27 toward aircraft C and aircraft A. He was instructed to abort and stopped on the runway.

The communications errors leading to these problems consist of phonetic similarities, transpositions, inaccuracies, ambiguities, garbling, and untimeliness.

Deviations from aircraft intended trajectory: ASRS reports record many instances of aircraft departing from assigned altitudes or headings during approaches or departures in airport traffic area airspace. Communications problems are an important factor in such trajectory deviation, sharing the burden of causation with poor flying technique on the part of flightcrews. Most communications problems involved misunderstood clearance; failures to issue appropriate clearances and failures to change frequencies properly also accounted for a significant number of the deviations. It is noteworthy that altitude deviations predominated in this fault category.

ATC cleared us to descend to 2,000. At 2,500 we spotted aircraft B 3/4–1 mile ahead at eleven o'clock at about 3,000. We advised ATC, controller asked our altitude, then stated he had cleared us to 4,000, and advised us to maintain visual separation from B. Then he cleared us to climb to 4,000. B passed above and behind our position.

En Route Operations

The en route operations evaluation concerned communications problems that arose when aircraft under ATC control were cruising en route or transitioning to or from the cruise condition. Many of these problems are traceable to difficulties of ATC coordination within and between control facilities. Most of the problems that were related to difficulties in air-to-ground communication were of three types: altitude deviations, failures of flightcrews to respond effectively to clearance amendments for conflict avoidance, and a variety of difficulties related to weather avoidance.

Aircraft A was cleared to cross 10 n. mi. east of XYZ at FL310, then descend to FL240 at pilot's discretion 14 n. mi. east of XYZ; A's altitude readout was FL320. At 10 n. mi. east the pilot was asked his altitude and he reported FL320. He was issued traffic ten o'clock, 8 miles, flight level 330, northeast bound. I was on a busy position alone and had conflict alert not come on, I would not have caught this in time. Pilot called on frequency and apologized for not making his restriction.

Altitude deviations– One of the types of incidents that has the greatest potential for causing serious accidents is failure that results in an aircraft being at an altitude other than that assigned by air traffic control. This is especially serious when an altitude restriction has been issued during climb or descent. Restrictions are issued because of conflicting traffic, and failure to comply will almost always result in loss of separation.

We requested descent clearance. Center asked whether it was necessary that we begin descent at that time, and I replied it was, or we would be unable to get down without circling. Center then gave us a 60° vector turn to the right to avoid conflicting traffic 2,000 ft below us. This was misunderstood by the copilot, and, as he had the conflicting traffic in sight, began descent. I had switched to monitor ATIS and did not notice he had begun descent until he had reached FL320. I asked if he had received further descent clearance. He had not and began climb back to FL330. Since we had the traffic in sight safety was not jeopardized, but it could have been in IFR flight conditions.

Clearance amendment response– Clearances are usually amended because of potential or present conflicts. A routine clearance may be issued, then a change in the traffic situation makes it necessary that the clearance be amended. Altitude assignments, heading assignments, and speed control are sometimes misunderstood by the recipient and the read-back, if given, may not be noted by the controller. Such clearances are usually time-critical and errors frequently result in loss of standard separation.

After obtaining position reports from departing aircraft A 3 n. mi. SE XYZ leveling at 5,000 and arriving aircraft B 30 n. mi. E XYZ, A was asked if he would like the

> Victor airway. He asked the radial and concurred and was recleared via Victor airway to maintain 5,000 and report passing the 246 radial of XXX VOR. B was recleared via the north Victor airway to cross the 18 DME fix at or below 4,000. Aircraft A reported crossing the 246 radial and was cleared to climb to 7,000. Shortly thereafter, Center reported getting aircraft A on radar and that A and B were head-on about 8 n. mi. apart on Victor airway north. Clearance was issued to A to stop climb and B to stop descent but the aircraft sighted each other passing about 1/2 mile apart at near the same altitude.

Weather avoidance– In periods of rapidly moving frontal activity or summer thunderstorms, weather avoidance becomes a major factor in en route operations. Deviations from planned routes become commonplace and there are frequent incidents involving uncoordinated penetration of airspace assigned to another aircraft or to a different air traffic controller.

> Two northbound aircraft B and C on separate jet routes at FL330 were deviating from course to circumvent thunderstorm buildups. Aircraft A was a no-radio contact aircraft in the same area and B and C were provided separation from A. B was expected to follow C but he had deviated right of course 5 to 8 n. mi. Separation from C was decreasing. Controller attempted vectors to increase separation but pilot response was slow. Therefore, controller cleared B to FL290 and heading 330. Again, pilot responded slowly but separation increased.

The Party Line Concept

A popular point of view among pilots is that there is substantial benefit in the "party line" concept, that is, that monitoring of a communication frequency can provide useful information, for example, about traffic flow and location of other traffic. Many pilots make extensive use of this practice, particularly at noncontrolled airports or at lower-activity terminals served by a control tower.

> I was in aircraft A cleared through the airport traffic area at 2,500 MSL. While passing over the field, I heard the tower clear aircraft B for takeoff on 31L. He was to climb to 3,000 MSL on a 270° heading. I kept looking, but was unable to see him. The tower never did advise me he was coming. At about 6 miles west I saw him as he climbed out from under my left wing. He was traveling extremely fast and passed about 200 to 300 ft from me.

Some pilots contend that this is the usual means of acquiring a mental picture of the current traffic situation.

The beneficial use of party line is mentioned incidentally in several ASRS reports that are concerned with some other primary occurrence; this is because almost all reports concern an unsafe incident or condition. This report is an illustration.

> I was descending to 1,500 MSL in aircraft A and had been told to enter left downwind for runway 05, approaching the airport from the northwest. Aircraft B had just departed runway 05 and asked for a left turnout to the northwest. The tower

> approved and said, "No reported traffic." Immediately, I began looking and saw him approaching me on a collision course. Evasive action was required on my part. Aircraft B passed my right wing less than a mile. I don't think he ever saw me, because the tower had told him there was no traffic NW of the airport.

Party line effectiveness must be evaluated in terms of the number of aircraft on a common frequency that are pertinent to the traffic situation. In large terminals, approach control is sectorized; local control is sometimes divided by the runways in use; ground control is split; and departing aircraft may still be in terminal airspace after being changed to center frequency. Many military aircraft are equipped with UHF only. Frequency monitoring may disclose only a fraction of the traffic that could be involved in an incident.

Errors can result from misunderstanding an overheard transmission, when a pilot may initiate an action based on his misperception of the message content. Some ASRS reports concern pilots acting on a clearance intended for another aircraft. This is an example of such an occurrence.

> Aircraft A was told to taxi into position and hold on runway 35 while aircraft B was on landing rollout. Aircraft C was told to taxi into position and hold on runway 23 behind aircraft D. Aircraft B, landing on runway 33, was holding short of runway 23. When aircraft B turned off runway 33 and aircraft D rolled past the intersection of runways 23 and 33, aircraft A was told to turn right heading 090 after departure, cleared for takeoff. Aircraft C (holding on runway 23) thought the clearance was for him and started takeoff roll. Aircraft A was rolling also. The local controller did not hear aircraft C acknowledge for the takeoff clearance nor did he see aircraft C start takeoff roll until it was too late. Aircraft A and aircraft C missed by approximately 200 ft at the intersection.

Party line is also capable of making useful information available. The relative position and flightpath of other aircraft can often be ascertained when they are not in view. The intentions of the pilot may be overheard and, therefore, they may be taken into account in planning future courses of action.

But the use of simplex communications also poses the problem of misunderstanding by the intended recipient of a transmission, the problem of blocking of reception by another transmission, and the possibility of a clearance being accepted and acted upon by other than its intended recipient.

CONCLUSIONS

It is concluded that ATC-aircraft communications problems are involved in a large fraction of the occurrences reported to the ASRS. Many or most of these communications problems involve human errors on the part of the sender or receiver of the message. A small number are associated with breakdown of communications equipment, frequency saturation, and other system factors. The air-ground communications link is the cornerstone of the present system for the control of air traffic, and the problems observed in this study constitute a threat to the integrity and safety of the aviation system.

REFERENCE

1. Grayson, R. L.: Effects of the Introduction of the Discrete Address Beacon System Data Link on Air/Ground Information Transfer Problems. NASA Contractor Report 166165, July 1981.